EDITORIAL

Non-invasive tests in coronary artery disease: are we facing a fork in the road?

Mario J Garcia

Heart 2007;**93**:413–414. doi: 10.1136/hrt.2006.108811

See article on page 423

Every year, over 500 000 US and 120 000 UK residents die of ischaemic heart disease. In 2002, cardiovascular and cerebrovascular disorders accounted for >25% of all deaths in most developed countries.[1] The economic and social burden of atherosclerosis has a global reach. In India, one of the two most populated countries, ischaemic heart disease represents the most prevalent cause of death. Even though the last two decades have seen significant advances in preventive therapeutic strategies, a substantial proportion of individuals with coronary and cerebrovascular disease is diagnosed at the time of presentation with myocardial infarction or stroke. Hence, establishing early accurate diagnosis in those patients who are at risk has great potential for reducing cardiovascular events and extending life expectancy.

In this issue of *Heart*, Gershlick *et al*,[2] from the British Cardiovascular Society Working Group, provide an analysis of the role of current non-invasive tests in patients with known or suspected coronary artery disease. Based on their expert opinion, they issue recommendations for appropriate utilisation. They also forecast implementation of these tests in the UK over the next decade. The value of expert opinion in this topic cannot be understated. At a time when healthcare costs continue to rise at alarming rates, medical imaging has been a focus of attention. The increasing utilisation of medical imaging is driven by multiple factors, including new technological development, patient demand, medical malpractice concerns, physician and hospital reimbursements, and health outcomes. Unfortunately, the benefits of diagnostic testing are more difficult to establish than the benefits of specific therapeutic interventions. Furthermore, the rate of technological development outpaces the collection of health outcome data.

There are five non-invasive tests examined by Gershlick *et al*[2] in the current review: regular ECG stress testing (ETT), stress echocardiography (SE), myocardial perfusion imaging (MPS), cardiac magnetic resonance (CMR) and multi-detector computed tomography (MDCT). As highlighted by the authors, these tests provide anatomical and/or functional information in patients with known or suspected coronary artery disease that may replace the need or complement invasive coronary angiography (CA). These tests have been traditionally judged by their accuracy in establishing the diagnosis and by their prognostic utility.

Undoubtedly, the authors are correct in their assessment regarding use of invasive CA. The current utilisation rate of CA in the UK is much lower than in the US. But even in our country, if one could rely only on this method for evaluating patients at risk, the number of catheterisation laboratories would need to be significantly expanded. Moreover, the healthcare costs and complications related to the increasing utilisation of this procedure would be expected to increase significantly.

The task of assigning the relative value or the order in which non-invasive tests should be applied is more difficult due to several reasons. (1) It is difficult to compare older established modalities such as ETT, SE or MPS with the relatively newer MDCT and CMR, given the lack of prognostic information available with the latter. (2) The relative value of any of these imaging tests is strongly affected by the pre-test likelihood of disease. For example, the positive predictive value of MPS is low when applied to populations with low prevalence of disease. Conversely, the negative predictive value of SE is reduced in high-prevalence groups; therefore, MPS or even directly proceeding with invasive CA may be preferred in this setting. (3) The value of exercise stress tests is dependent on the ability of the patient to exercise to an adequate level. With the increasing age of the population and the growing epidemic of obesity, the proportion of patients who cannot be adequately evaluated by exercise stress is becoming more significant. Although pharmacological stress may be performed to detect ischaemia, much valuable prognostic information can be derived only from exercise variables. (4) The prognostic value and the diagnostic accuracy of a test cannot be accepted as equivalent. It is true that a patient who has been evaluated for symptoms of chest pain has good short-term prognosis if an ETT, SE or MPS shows adequate exercise tolerance and no ischaemia. However, this finding does not reliably exclude the presence of coronary artery disease or establish that coronary obstruction is not the cause of chest pain. Thus, in clinical practice, patients with persisting symptoms eventually end up undergoing further testing until a diagnosis is established. Moreover, the difference in short-term prognosis between patients with no ischaemia and

Correspondence to:
Dr M J Garcia, Cardiovascular Institute, Mount Sinai Hospital, One Gustave Levy Place, New York, NY 10029, USA; mario.garcia@mountsinai.org

Abbreviations: CA, coronary angiography; CMR, cardiac magnetic resonance; ETT, ECG stress testing; MDCT, multi-detector computed tomography; MPS, myocardial perfusion imaging; SE, stress echocardiography

those with single-vessel ischaemia, which together encompass the vast majority of patients studied, is very small. In a study that included over 5000 patients undergoing SE, those with normal results and those with single-vessel territory ischaemia had similar survival rates (99%) within the first year.[3]

This brings us to the question of whether the paradigm of functional testing alone is adequate or whether we need to define the coronary anatomy. Although coronary imaging with CMR has been studied, MDCT is clearly the modality that could seriously challenge the current paradigm. Clearly, MDCT has a superior negative predictive value; thus, a negative MDCT virtually excludes the presence of anatomical coronary artery disease. In addition, MDCT potentially excludes other important causes of chest pain such as pneumothorax, dissection, oesophageal pathology or large pulmonary embolism, making it very attractive as a diagnostic test in this setting. As discussed by the authors, MDCT has limitations—in particular, its reduced ability to visualise the coronary lumen in the presence of extensive coronary calcifications or stents.[4] The radiation exposure with current systems also raises concern about its indiscriminate use in younger, low-risk patients. I therefore agree with the authors in their recommendation of using MDCT as a secondary test for patients with equivocal stress test results. However, technological advances are being implemented at a much faster speed with this technology than with any other imaging modality. Compared with 16-slice MDCT, current 64-slice MDCT systems reduce acquisition time and lower the number of non-evaluable segments. With the implementation of prospective triggered acquisition, some 64-detector systems have recently shown the feasibility of performing CA with only 2–4 mSv of radiation exposure. Prototype units with 256-slice MDCT systems are already under clinical investigation. Therefore, I believe that current recommendations will need to be revised much sooner than 3 years from now. I anticipate that eventually MDCT will prove to be equivalent or even superior to stress testing as a first-line test, particularly in patients with low–intermediate risk, given its higher negative predictive value. MDCT has the unique advantage of being able to establish the presence of coronary artery disease at an earlier stage compared with any other non-invasive imaging modality.

It is difficult to forecast how rapid the growth of CMR will be in the next few years. The costs of the equipment, installation and maintenance, and the more difficult implementation of exercise protocols are in balance with the higher spatial resolution of CMR, when compared with SE and MPS. However, CMR will experience significant growth in the future once anatomic coronary imaging is performed reliably with this modality. The use of harmonic imaging, real-time 3D and contrast will likely continue to improve the image quality and ease of acquisition with SE. Newer high-sensitivity gamma detector systems are now close to commercialisation. These small footprint systems significantly reduce radiation exposure and acquisition time during MPS. Thus, CMR, SE and MPS will remain in close competition for functional imaging. Meanwhile, MDCT is at a clear advantage for anatomic coronary imaging at the present time. Accordingly, I differ with the authors' opinion and predict that the number of new MDCT system installations in the UK will actually exceed the number of installations of new CMR systems over the next 10 years.

Having ETT, SE, MPS, CMR and MDCT to choose from is, to the practicing clinician, similar to approaching a fork in the road. Yogi Berra once said, ''If you come to a fork in the road, take it.'' However, in healthcare we cannot afford to just ''take the fork'' and perform every test in every patient. For this reason, we share the vision of the authors regarding the establishment of a non-invasive cardiac imaging track in cardiology training. We anticipate that the future multimodality cardiovascular imaging experts will serve the role of consultants, helping in determining which is the most appropriate test for a given patient in a given clinical circumstance to reach the most accurate and complete diagnosis, ultimately providing better patient care.

Competing interests: None declared.

REFERENCES

1 **World Health Organization Statistical Information System**. Mortality Profiles 2005. http://www.who.int/whosis/mort/profiles/en/index.html.
2 **Gershlick AH**, de Belder M, Chambers J, *et al*. Role of non-invasive imaging in the management of coronary artery disease: an assessment of likely change over the next 10 years. A report from the British Cardiovascular Society Working Group. *Heart* 2007;**93**:423–31.
3 **Marwick TH**, Case C, Vasey C, *et al*. Prediction of mortality by exercise echocardiography: a strategy for combination with the duke treadmill score. *Circulation* 2001;**103**:2566–71.
4 **Garcia MJ**, Lessick J, Hoffmann MH. CATSCAN study investigators. Accuracy of 16-row multidetector computed tomography for the assessment of coronary artery stenosis. *JAMA* 2006;**296**:403–11.